

# Case Study of How Turkish University Students Improve Their Biochemistry Achievement

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## Abstract

Biochemistry courses have an important place as a common subject in faculties of medicine, food engineering, biology and chemistry. MSLQ, Metacognitive Awareness Inventory and Learning Approach Questionnaire were used. The study also involves repeated observations of the same instructor in a biochemistry class over eight weeks to describe students' academic performance, instructor practice, teaching methods and generally, learning environment in the biochemistry class. Students achieving the two highest scores, two average scores and the two lowest scores from biochemistry exams were selected for in-depth interviews and results demonstrated that self-efficacy, intrinsic goal orientation, task-value, cognitive strategies such as critical thinking ability and elaboration, metacognitive self-regulated strategies and effort regulation may have a considerable importance in students' biochemistry achievement. Results of the study also revealed that levels of students' awareness of what and how they monitor in their biochemistry learning process has an important effect on their biochemistry success.

**Keywords:** metacognitive awareness, motivational beliefs, learning strategies

## 1. Introduction

Biochemistry has an important role to understand common topics in medicine, chemistry and biology curriculum. Especially, the interrelationships between biology and chemistry subjects, like chemical reactions in our body are the main function to keep us alive. Students in the department of biology and chemistry should recognize the fundamental importance of biochemistry, because they have to use their biochemistry knowledge to understand developments in biotechnology, natural sciences, health sciences, nutrition and environmental events. Therefore, this study aims to identify the factors leading to the failure of students to achieve acceptable levels of understanding in biochemistry courses.

For many years, educational researchers have continued to show factors affecting the students' science achievements and most of the studies were conducted to improve students' science achievement by taking into account of students' conceptual development and cognitive processes, metacognition, motivational beliefs and teaching/learning strategies (Diseth, 2011; Sungur & Gungoren, 2009; Warr & Downing, 2000). In recent studies, it was stated that learning how to learn in science is very important to have effective science education to develop students' scientific literacy (Englert et al., 2009). Motivational and learning strategies, which are directly related with the skills of learning how to learn, have an imperative role in all educational systems (Warr & Downing, 2000; Wolters, 1998). Successful and effective science education depends on how much students are using their motivational and self-regulated learning strategies while studying the science in general (Pokay & Blumenfeld, 1990). Wolters and Rosenthal (2000) stated that students who are highly motivated about performance in the classroom are more successful than students who are less motivated in the lectures.

The components of students' motivational beliefs can be listed basically as goal orientations, task value, control beliefs, self efficacy and test anxiety (Pintrich & De Groot, 1990). Looking at the research evidence cited in the literature, it is understood that each motivational variables can be used to predict students' achievements (Sungur & Gungoren, 2009; Zimmerman, Bandura & Martinez-Pons, 1992). Moreover, in the context of science learning and teaching, how the self-regulated learning strategies influence students' science achievement was demonstrated. Self-regulated learning strategies involve the use of cognitive and metacognitive strategies and time/study environmental management (Garcia & Pintrich, 1994; Artino, 2005). Cognitive learning strategies

consist of rehearsal, elaboration, organization and critical thinking (Bartels, Magun-Jackson & Kamp, 2009). Each of these cognitive strategies is related with academic performance (e.g., recall of information, words, or lists; understanding a piece of text or a lecture) in the classroom (Weinstein & Mayer, 1986). The other self-regulated learning strategy is the metacognitive self-regulation defined as the awareness, knowledge and control of cognition including planning, monitoring, and regulation (O'Malley & Chamot, 1990). Students' metacognitive self-regulated strategies are significantly correlated with their academic achievements (Kert, 2008; Loyens, Rikers & Schmidt, 2008). Furthermore, time and study environmental management is the resource management strategy dealing with the current study as self-regulated learning strategies (Pintrich & De Groot, 1990). Research in the field of resource management was resulted in consistent relations in between the time/study environmental management and students' academic achievement (Ning & Downing, 2010). As reported by Hurk (2006), students who use time/study management strategies, are more successful in the classroom and more efficient in using cognitive strategies than others who are not using. Looking a theoretical framework for students' motivational and self-regulated learning strategies, it was demonstrated that search of motivational and learning strategies of students is a factor that may have an effect on their biochemistry achievements.

Recent studies have also emphasized the importance of metacognition for students learning process in science topics. Metacognition was defined as "the monitoring and control of thought" (Martinez, 2006, p. 696). In other words, it refers to the students "learn how to learn". It has two components namely knowledge and regulation of cognition (Brown, 1987). and knowledge of cognition refers to what students know about their own cognition and includes declarative, procedural, and conditional awareness (Brown, 1987; Schraw & Moshman, 1995). The first type of awareness is the declarative knowledge comprising the understanding which factors can influence student's performance (Schraw & Moshman, 1995) and procedural knowledge take account of implementation of strategies or procedural skills (Kuhn & Dean, 2004). The last type is the conditional knowledge including comprehension of when and why to apply different strategies or cognitive actions (Lorch, Lorch and Klusewitz, 1993). Second component of metacognition is the regulation of cognition referring to metacognitive activities, which helps to control one's thinking or learning abilities. Three essential skills; planning, monitoring and evaluation are essential in regulation of cognition (Schraw & Moshman, 1995) and planning consist of selection of proper strategies to achieve intended goal. The second essential skill comprises the participation in self-testing of individuals' academic actions and evaluation skills include reviewing or examining the academic process and products of one's learning outcomes (Schraw & Moshman, 1995; Whitebread et.al., 2009). Many metacognition and science researchers emphasized that metacognitive skills incorporates the conscious structuring of knowledge and it is the key components to enhance students' motivation for learning (Bransford et al., 1986 cited in Dawson, 2008). Based on research illuminating the importance of metacognition, recent studies have focused on the role of metacognition on students' biochemistry learning.

Learning approaches of the students can be classified as another factor taken into account to explain the effect of it on students' biochemistry achievement. Learning approach is a cognitive variable measuring the students' learning orientation and meaningful learning will come about when new knowledge is associated with pre-existing ideas (Ausebel, 1968). Rote learning is explained as new knowledge which may be attained by verbatim memorization and person construct knowledge without connecting it to preexisting ones (Ausebel, 1963; Baird, 1986). There are many studies about the relationships between science achievement and learning orientation in the literature (Reap & Cavallo, 1992; Cavallo & Schafer, 1994; BouJaude, Salloum & Khalick, 2004; Araz & Sungur, 2007). In one of these studies, Araz and Sungur (2007) stated that meaningful learning has a direct effect on students' achievements in genetics. Similarly, Cavallo and Schafer (1994) proposed that meaningful learning orientation contributes to the students' achievement in topic of meiosis. Many of these afore-cited studies provide substantial evidence in favor of the significant effect of meaningful learning on students' achievement but none of these can explain which techniques are the biochemistry students prefers as a learning orientation. Therefore, the current study aimed to identify learning orientations which may be a factor affecting students' biochemistry achievement.

Current science education literature involves several case studies to determine possible reasons that effect university students' achievement. Especially, most of the studies were related to students' biotechnology education, knowledge and attitudes toward biotechnology (Incekara & Tuna, 2011; Altun, Celik & Elcin, 2011; Usak, Erdogan, Prokop & Ozel, 2009; Severcan, Ozan & Harris, 2000). These studies provide substantial evidence in biotechnology education but they could not explain the factors affecting biochemistry achievement. Particularly, in the related literature, there is no such a study investigated the effect of motivational and learning strategies, knowledge and regulation of cognition and learning approaches on university students' success.

Furthermore, there is no case study to investigate how possible factors under cognitive and motivational variables, metacognitive awareness and learning approaches can be used to explain students' biochemistry failure at the university level in Turkey. For that reason, the present study also aimed to investigate the variables that effect on Turkish university students' biochemistry achievement.

## 2. Method

The design of this research was an exploratory case study and an empirical inquiry that investigate the possible effects of Turkish university students' motivational and learning strategies, learning approaches and metacognitive constructs on biochemistry achievement within a real-life context (Yin, 2006 cited in Oliver & Venville, 2011), the biochemistry classes. Research in related literature has traditionally based on survey approaches (questionnaires); however, this cannot be enough to understand the causes of students' failure in biochemistry courses. According to Simons (2009), a case study is an important and effective way to understand how people think, feel and act. These properties of the case studies permit an in-depth investigation of factors which may have an effect on students' biochemistry success within learning environment. In the present study, questionnaires, interviews and observations were used to understand variables and factors that effect students' biochemistry achievements. Therefore, the purpose of this case study is to identify the role of motivational and learning strategies, metacognitive constructs and learning approaches on students' achievement in biochemistry courses.

### 2.1 The Participants

The present study was conducted with 25 university students (18 girls and 7 boys) with an age ranging from 20 to 23, with a mean age of 21.16 (S.D=.89). The university is situated in a Region of Central Anatolia of Turkey. Biochemistry students were identified through purposeful sampling. Students' survey scores were analyzed with respect to their final course grades. Two (8%) biochemistry students got A score (4.0 out of 4.0), six (24 %) got B score (3.0 out of 4.0), six (24 %) biochemistry students got C score (2.0 out of 4.0), and eleven of them (44%) received a D (1.0 out of 4.0). For data analysis, biochemistry students were divided into three groups of high achieving students (the 2 students that earned A's), average achieving students (the 6 students that earned B's), and low achieving students (the 17 students that earned C's and D's). Having determined the participants for research purposes, one biochemistry instructor and all students were observed for eight weeks. In the study, all of the students took the same questionnaires. Two high achieving students, two average achieving students and two low achieving students were chosen for the interviews.

### 2.2 Data Collection

Data in the current study were collected by three methods; (1) using three questionnaires as The Motivated Strategies for Learning Questionnaire (MSLQ), Metacognitive Awareness Inventory (MAI) and Learning Approach Questionnaire (LAQ) about students' motivational beliefs and learning strategies, metacognitive constructs and learning approaches; (2) conducting in-depth interviews with biochemistry students; (3) using a "structured observation forms" over eight weeks in biochemistry classes. Surveys were used to describe students' motivations to learn biochemistry, metacognitive constructs on knowledge of biochemistry and learning orientations. The interviews provided evidence to clarify the most important factors affecting their biochemistry achievement. Finally, observations were useful to present additional information about the possible factors which affect students' failure in biochemistry classes. Therefore, data triangulation (Yin, 2009) occurred with multiple data sources to ensure alternative explanations about important factors in students' biochemistry achievement.

#### 2.2.1 The Motivated Strategies for Learning Questionnaire (MSLQ)

The Turkish version of the Motivated Strategies for Learning Questionnaire (MSLQ; Sungur, 2004) was used to measure students' motivational orientations and learning strategies. The MSLQ, developed by Pintrich, Smith, Garcia and McKeachie (1993), is a self-report instrument to measure motivation and self-regulated learning strategies. The motivation section consists of 31 items with six subscales namely intrinsic and extrinsic goal orientations, task value, control of learning beliefs, self-efficacy for learning and performance, test anxiety. The self-regulated learning strategies consists of 50 items with nine subscales namely rehearsal, organization, elaboration, critical thinking, help seeking, peer learning, metacognitive self-regulation, effort regulation, time and study environmental management strategies. Cronbach alpha coefficient for the whole scale was presented at the Table 1 and Table 2.

Table 1. Number of items and reliability coefficients of the motivational section of MSLQ scales

Scale	Number of Items	Cronbach Alpha Coefficients
I. Motivation section	31	.80
Intrinsic goal orientation (IGO)	4	.60
Extrinsic goal orientation (EGO)	4	.60
Task value (TV)	6	.86
Control of learning beliefs (CLB)	4	.70
Self-efficacy for learning and performance (SE)	8	.72
Test anxiety (TA)	5	.60

Table 2. Number of items and reliability coefficients of the motivational section of MSLQ scales

Scale	Number of Items	Cronbach Alpha Coefficients
II. Self-regulated learning strategies section	50	.86
Rehearsal (R)	4	.71
Elaboration (E)	6	.63
Organization (O)	4	.60
Critical thinking (CT)	5	.72
Metacognitive self-regulation (MSR)	12	.68
Time and study Environmental management strategies (TMS)	8	.60
Effort regulation (ER)	4	.60
Help seeking (HS)	4	.62
Peer learning (PL)	3	.55

## 2.2.2 Metacognitive Awareness Inventory (MAI)

The Turkish version of Metacognitive Awareness Inventory (MAI) was used to measure biochemistry students' levels of metacognition awareness (Akin, Abacı & Cetin, 2007). The MAI, developed by Schraw and Dennison (1994), consists of 52 items loaded into 2 factors as knowledge of cognition and regulation of cognition and used a five-point Likert-type scale ranging from "Always True" (5 point) to "Never True" (1 point). Knowledge of cognition includes three subscales namely, declarative, procedural, and conditional and regulation of cognition includes five subscales namely planning, monitoring, evaluation, information management and debugging. Cronbach alpha coefficient for the whole scale was presented at the Table 3.

Table 3. Number of items and reliability coefficients of the MAI scales

Scale	Number of Items	Cronbach Alpha Coefficients
I. Knowledge of Cognition	17	.77
Declarative	8	.60
Procedural	4	.60
Conditional	5	.55
II. Regulation of Cognition	35	.88
Planning	7	.64
Monitoring	8	.72
Evaluation	6	.67
Information management	9	.74
Debugging	5	.55

### 2.2.3 Learning Approach Questionnaire (LAQ)

The Turkish version of Learning Approach Questionnaire (LAQ) was used to measure students' orientation to learning ranging from meaningful to rote (Yenilmez, 2006). The LAQ, developed by Cavallo (1996), consists of 22 items and used a four-point Likert-type scale ranging from "Strongly Disagree" (1 point) to "Strongly Agree" (4 point). The scores obtained therefore range from 88 to 22. The possible ranges of both LAQ-M (Meaningful Learning Approach Questionnaire) and LAQ-R (rote learning approach questionnaire) are 11-44. Cronbach alpha coefficient for the whole scale was presented at the Table 4.

Table 4. Number of items and reliability coefficients of the LAQ scales

Scale	Number of Items	Cronbach Alpha Coefficients
LAQ	22	.81
LAQ-M	11	.75
LAQ-R	11	.64

### 2.2.4 Interview Guide

Semi-structured open-ended interview was used to focus the possible factors that affects students' biochemistry achievement. According to Neala, Thapa and Boyce (2006), interviews are one of the important sources to complete a picture in case studies. Face-to face interviews occurred with students who achieving the two highest scores, two average scores and the two lowest scores from biochemistry exams. Information collected about learning environment and students' views about the factors that cause their failure on biochemistry courses.

### 2.2.5 Observation Form

The structured observation form was used to uncover factors that are important to understand reasons of students' failure in biochemistry courses. Direct observation of teaching progress provides a holistic view of learning and teaching process in the learning environment. Moreover, the potential benefit of observations consists of the interactions taking place between the teacher and students as well as among the students themselves. In the current study, two classroom observation forms were prepared to observe both students and an instructor. The student observation form covers three main issues namely, students' motivation for learning biochemistry, students' preparation for biochemistry course and students' participation to the biochemistry lessons. Secondly, the instructor observation form covers three general issues namely, content organization, teaching process in the biochemistry class, class management strategies/communication with the students. Using these forms, biochemistry classroom was observed by the same researcher over eight weeks and the data were obtained via observations and interpreted.

## 2.3 Data Analysis

The data obtained via surveys and observations were analyzed by means of SPSS 16.0 statistical software. Descriptive statistics were generated to provide a general judgment about biochemistry students' motivational orientations and self-regulated learning strategies, levels of metacognitive awareness and learning approaches. Data from the observation forms were analyzed using basic procedures such as mean scores of the variables. Also, analysis of semi-structured interview questions provided extra richness of understanding and insights.

## 3. Results

### 3.1 Descriptive Statistics of Biochemistry Students' Motivational Beliefs and Self-Regulated Strategies

Descriptive statistics related to scores which were measured by MSLQ scores were presented at Table 5 and Table 6. The mean and standard deviation (SD) were presented for biochemistry students with respect to achieving levels in final course grades.

Table 5. Descriptive Statistics for the motivational variables of MSLQ

	High achieving		Average achieving		Low achieving	
	SD	Mean	SD	Mean	SD	Mean
IGO	5.04	1.41	4.25	2.48	4.85	2.33
EGO	4.50	1.41	5.70	3.76	5.38	3.25
TV	6.50	3.24	5.88	2.73	4.24	3.50
CLB	6.38	1.70	6.41	1.86	6.20	3.14
SE	5.13	1.89	4.95	2.65	3.91	3.75
TA	4.50	2.94	4.77	3.15	5.10	5.58

IGO: Intrinsic goal orientation, EGO: Extrinsic goal orientation, TV: Task value, CLB: Control of learning beliefs, SE: Self-efficacy, TA: Test anxiety

Table 5 presents mean and standard deviations of the motivational orientations of high, average and low achieving biochemistry students. Looking for the intrinsic goal orientations for all of groups, high achieving students had higher score than average and low achieving students. Conversely, average and low achieving students had higher score on extrinsic goal orientation than students achieving high scores. Moreover, task value score for high achieving groups was higher than the groups achieved at average scores. Both groups had higher mean scores than low achieving students. Similarly, mean scores of control of learning beliefs of high and average achieving students were slightly higher than low achieving ones. Moreover, high achieving students had higher self-efficacy mean score than other achievers and average achieving students had higher self-efficacy mean score than low achieving ones. Finally, low scored students get higher test anxiety scores as compared to these of both high and average achieving students.

Means and standard deviations self-regulated strategies with respect to achieving groups were demonstrated in Table 6. The mean scores of rehearsal and organization of high achieving and low achieving students were similar to each other and lower than those of average achievers. However, students belonging to higher achiever groups' elaboration scores were higher as compared with average and low scored ones. It is noteworthy that, higher achieving students had the highest mean score of critical thinking ability than average and low achieving students and also average achieving students had more critical thinking ability scores than low achieving students. Looking at metacognitive self-regulated strategies mean scores, high and average achieving students had similar scores and both of them had higher scores than low achieving ones. Additionally, in resource management strategies, time and study environmental strategies scores for all achieving group were similar to each other. On the other hand, effort regulation scores of high achieving students were higher than other students and average achieving students had high effort regulation mean scores than low achieving students. As for help seeking mean scores, average and low achieving students had similar scores which were higher than high achieving students. Peer learning scores of average achieving students were higher than both high and low achieving students.

Table 6. Descriptive Statistics for the self-regulated learning variables of MSLQ

	High achieving		Average achieving		Low achieving	
	SD	Mean	SD	Mean	SD	Mean
R	5.63	2.94	6.29	1.94	5.35	3.80
E	5.58	2.94	4.80	3.01	4.50	3.50
O	5.87	2.94	6.00	2.09	5.26	3.11
CT	5.20	3.48	4.70	3.14	3.35	3.46
MSR	5.42	2.82	5.12	3.92	4.66	3.25
TMS	4.75	2.82	4.77	2.63	4.88	3.57
ER	4.79	2.12	3.49	1.83	2.75	3.87
HS	3.87	3.53	4.83	2.58	4.38	3.25
PL	3.50	2.12	4.10	1.96	3.14	3.53

R: Rehearsal, E: Elaboration, O: Organization, CT: Critical Thinking, MSR: Metacognitive self regulation, TMS: Time and study environmental management, ER: Effort regulation, HS: Help seeking, PL: Peer learning

### 3.2 Descriptive Statistics of Biochemistry Students' Levels of Metacognitive Awareness

Descriptive statistics related to scores which were measured by MAI were presented at Table 7.

As stated in Table 7, the mean score of knowledge of cognition to all achieving students were similar to each other. There was not so big difference between subscales of knowledge of cognition of students. However, when looking at the scores of regulation of cognition it is obvious that high achieving students had higher total score on subscales of regulation of cognition than average and low achieving students' mean scores on the same subscales. Also, average and low achieving students had similar mean scores on regulation of cognition.

Table 7. Descriptive Statistics for the level of metacognitive awareness

	High achieving		Average achieving		Low achieving	
	SD	Mean	SD	Mean	SD	Mean
<b>Knowledge of cognition</b>						
Declarative	4.00	2.12	3.95	2.65	3.90	3.18
Procedural	3.50	2.82	3.54	3.86	3.72	1.90
Conditional	4.10	2.12	4.16	1.75	4.05	2.96
<b>Regulation of cognition</b>						
Planning	3.87	2.56	3.47	3.08	3.78	3.16
Monitoring	4.28	3.53	4.08	4.28	3.85	3.75
Evaluation	4.50	1.25	3.88	3.38	3.65	3.55
Information manag.	4.22	2.12	4.19	3.54	3.88	3.72
Debugging	4.50	2.12	4.06	1.36	4.10	3.36

### 3.3 Descriptive Statistics for the Learning Approach Questionnaire

Descriptive statistics related to scores which were measured by LAQ were presented at Table 8. Accordingly, it is clear that all achieving students had higher scores on meaningful learning orientations than the scores on rote learning orientations. However, low achieving students had the highest mean scores on rote learning orientations.

Table 8. Descriptive Statistics for learning approach of students

	High achieving		Average achieving		Low achieving	
	SD	Mean	SD	Mean	SD	Mean
<b>Learning Approach</b>						
Meaningful Learning	34.95	3.24	32.90	2.19	32.52	3.46
Rote Learning	21.90	4.24	26.42	2.88	29.57	3.55

### 3.4 Interviews

The below questions and the answers collected as a result of interviews between samples of high, average and low achievers. The questionnaires given below include some semi-structured, open-ended interview questions that were helpful for obtaining further information about possible factors effecting students' biochemistry achievements.

#### High Achieving Students Interview

1) How do you attribute your success in biochemistry courses?

Student A: "I like biochemistry courses and I am willing to take this course since I am interested in the biochemical reactions."

Student B: "Biochemistry does not contain so much Latin words that is why I do not have to memorize these words, and also I really like to interpret biochemical reactions."

2) What are the learning strategies in your biochemistry courses?

Student A: "I prepare myself to subject before coming to biochemistry class and I am totally giving attention to the instructor during the class hours."

Student B: "I am trying to learn the subject at the class and I am asking everything than I do not understand related to the subject during the lecture."

3) For the understanding of course, which way do you prefer in your biochemistry courses during the classes?

Student A: "I take the notes what the teacher explain to us and I read the important points from the different biochemistry books."

Student B: "I take the notes during lecture."

4) Which factors may influence your motivation in your biochemistry courses?

Student A: "Physical conditions of the class and the other students."

Student B: "Behaviors of the teacher."

5) How would you describe your morale at biochemistry course?

Student A: "I'm going to class willingly and gladly."

Student B: "I really like to study biochemistry."

Average Achieving Students Interview

1) How do you attribute your success in biochemistry courses?

Student C: "I listen to my teacher carefully during the lecture"

Student D: "Lessons undergoing efficiently, I repeat the subjects after the lesson"

2) What are the learning strategies in your biochemistry courses?

Student C: "I am trying to motivate myself to listen to the lesson"

Student D: "I am trying to ask everything whatever I could not understand the subject"

3) For the understanding of course, which way do you prefer in your biochemistry courses during the classes?

Student C: "I take notes of the important points that the teacher explain during the course and I read the same subjects from the books"

Student D: "Lecture notes are really important for me, if I could not take notes somehow, I try to collect the notes from my friends"

4) Which factors may influence your motivation in your biochemistry courses?

Student C: "Sometimes, I could not motivate myself to listen to the teacher, especially, when I came to class unprepared, I cannot listen to course"

Student D: "Test anxiety affects me negatively and I am under stress during the lecture"

5) How would you describe your morale at biochemistry course?

Student C: "When I understand the subject, I will be very happy and I want to continue to learn different biochemical subjects"

Student D: "Generally, I want to learn something at the biochemistry course"

Low Achieving Students Interview

1) How do you attribute your success in biochemistry courses?

Student E: "I am not studying the biochemistry too much and the subjects are very complex and difficult for me"

Student F: "I am not studying the biochemistry for the exams and I do not attend the lectures on a regular basis. However, I believe that if I follow the subjects, I will become more successful"

2) What are the learning strategies in your biochemistry courses?

Student E: "I am trying to take notes at the lesson but I could not repeat these notes after the lesson, I just read them before the exams"

Student F: "I summarize the topics from course books and I start to study these notes before 3-4 days from biochemistry examination"

3) Which factors may influence your motivation in your biochemistry courses?

Student E: "When students are asking lots of questions, it distracts me and I could not concentrate on the subject"

Student F: "Other students ask everything in the class I think, most of the question is not necessary. Also, the teacher use graphics and pictures when explaining the subject, these techniques are not suitable for me and the subjects become harder"

4) How would you describe your morale at biochemistry course?

Student E: "When I understand the subjects, I like biochemistry and the courses go well, however; most of the time, I feel that I don't know anything about the biochemistry"

Student F: "Mostly, I feel that the biochemistry course is foreign for me and I get tired of the lecture"

5) What are the problems which are associated with your success in biochemistry courses?

Student E: "The topics of the biochemistry course are too complex for me and they are very difficult to understand efficiently. Therefore, I do not want to study this course, I just repeat the topics before examination. This method is not enough for me to be successful"

Student F: "First of all, I cannot concentrate on the biochemistry and I do not want to study the course. I believe that I do not understand the topics so I cannot get good grades. In the lectures, I depressed when other students understand the subjects"

### 3.5 Observations

Class observations illustrate that the mean score of students' motivation for learning biochemistry was 2.2 gained from students observation form. That means that students were not apparent target of attention and interested in the content area of the subjects. Therefore they missed the important points of the subject and did not study the topics after they finished the subjects in the classroom. The mean score of students' preparation for biochemistry course was 2.3 showing that most of the students did not know how to prepare themselves before the classes and they did not try to find different resources about the subject. However, students were seemed to have tenderness to participate the lectures (mean score of students' participation to the biochemistry lectures was 3.5). Even though they could not state some original statements and discuss different examples for the subjects due to the lack of study before the lecture, they are trying to be engaged in class discussions and talk about the subject.

Mean score of content organization was 3.5 obtained from instructor observation form. Students have stated that instructor gives the main purpose of the lesson and try to answer each question asked during the lecture. On the other hand, he could not summarize the important points because of time limitation. Secondly, the instructor supported the lectures with useful materials as audio-visual material, define and explain unfamiliar terms, concepts and theories with giving relevant examples (the mean score of teaching process was 4.2). On the other hand, it was observed that instructor could not maintain students' attention and some of the students can miss the critical points of the subject and could not catch the rest of the lecture. The instructor, sometimes, asked probing questions and encouraged them to think critically (the mean score of class management strategies / communication with the students was 2.3).

## 4. Discussion

The results of the present study indicate that motivational and self-regulated learning strategies, knowledge and regulation of cognition, students' approaches to biochemistry learning, students' preparation and participation to biochemistry course, teaching process, content organization and class management strategies may be possible factors influencing Turkish university students' biochemistry achievement.

Results revealed that the motivational variables especially, self-efficacy, intrinsic goal orientation and task value scores of high achieving students were superior than those of average and low achieving students. The effect of such variables on students' achievement has been stressed by several educational researchers (Diseth, 2011; Ning & Downing, 2010; Sungur & Gungoren, 2009; Liem, Lau & Nie, 2008). According to Al-Alwan (2008), high achieving college students have significant higher self efficacy than low achieving students. Students with higher self-efficacy are likely to be sure of themselves when facing a complex problem, to search for a solution, to put greater effort to be successful and to show intrinsic interest in the work (Sungur & Gungoren, 2009). Therefore, development of self-efficacy is more desirable for improving academic achievement of average and low achieving students. Teacher can provide specific feedback to students to help them to develop reasonable efficacy beliefs (Linnenbrink & Pintrich, 2003). Accordingly, for the present study, teacher can organize the biochemistry courses to have a positive impact on student self-efficacy (Linnenbrink & Pintrich, 2003). Moreover, the results of current study revealed that intrinsic goal orientation is another important variable to

have high biochemistry achievement. It was shown that students with an intrinsic goal orientation tend to value a deeper level of understanding of tasks than those with an extrinsic goal orientation (Lyke & Kelaher Young, 2006). Particularly, students who show higher biochemistry achievement were more inclined towards intrinsic goal orientation. Thus, development of intrinsic goal orientation is more desirable for improving academic achievement. To encourage intrinsic goal orientation of students, teachers can improve teaching practices by using different learning environment such as problem-based learning (Chyung, Moll & Berg, 2010). Sungur and Tekkaya (2006) reported that high school students who participated in problem-based learning had higher levels of intrinsic goal orientation, metacognitive self-regulation, and peer learning, compared to students in a traditional instructional setting. Problem-based learning (PBL) approaches have been incorporated into college level biochemistry classrooms. Furthermore, biochemistry students view PBL approaches favorably (Sonmez & Lee, 2003; Jaleel, Rahman & Huda, 2001). In the current study, the teacher tries problem-based learning approaches to promote students' intrinsic goal orientation. Another approach to stimulate intrinsic goal orientation is peer group learning (Song & Grabowski, 2006). For the present study, instructor generally used traditional instruction method in which he gave important concepts in an organized structure and wrote notes on the chalkboard about the definition of major biochemistry concepts. However, researchers suggest that peer group learning can help students to improve their goal orientation (Song, 2005; Torp & Sage, 1998; Hmelo & Ferrairi, 1997). According to Song (2004), working in peer group may facilitate students' intrinsic motivation.

For the present study, another motivational variable was the task value that could have an effect on university students' biochemistry achievement. High achieving students had higher score on task value than average and low achieving students. This result was consistent with previous researches (Eccles & Wigfield, 2002; Wigfield, 1994). Wigfield & Eccles (2000) reported that the students who have high task value for an activity is more likely to participate in that activity and exert more effort than other students who has lower value for the same activity. Therefore, students should understand the intent of the task to become successful in biochemistry courses. This study suggests that increasing low achieving students perceptions of task value can develop their biochemistry achievement. Fostering students' attainment value can raise students' awareness of the importance of biochemistry subjects and increase interest towards the course. For example, students should understand that the topics of biochemistry courses have an important place for subjects of the other courses such as molecular biology.

The present study also suggested that self-regulated learning strategies are the possible factors influencing university students' biochemistry achievement. Especially, the mean score of elaboration, critical thinking ability, metacognitive self regulation and effort regulation of high achieving students were higher than the score of average and low achieving students. Research has indeed shown that elaboration strategy which is classified as "deep learning strategy" (Graham & Golan, 1991) was related to academic performance in the classroom (Pintrich, 2004; Pintrich & De Groot, 1990). Elaboration strategy includes summarizing, creating analogies, generative note-taking, explaining the ideas and asking and answering questions (Weinstein & Mayer, 1986). Barker and Olsen (2002) stated that elaboration skills may lead to increase scores on tests of students' learning strategies and in their course grades. According to Pintrich and his colleagues (1993), elaboration strategies help students to integrate and connect new information with pre-existing knowledge. Just as elaboration strategies, critical thinking were positively related to academic performance since the students who have critical thinking skill can understand the logical connections between previously acquired knowledge and new situations in order to identify and solve problems, construct and evaluate arguments (Pintrich et al., 1993; Yeh, 1997; Daniels, 1998; Lipman, 2003). Critical thinking is a mental process on the issues to reach reasonable conclusion and act an important role in daily life to become a creative person (Phrakhruvisitpattanaporn & Asavabhum, 2012). Therefore, it is an important issue that teaching critical thinking skill is necessary to have students who follow an active and regular mental process by being aware of their own thinking processes. Researchers stated that different teaching methods can promote critical thinking ability (Caliskan, 2009; Walker, 2003). According to Caliskan (2009), inquiry based learning approach can develop students' critical thinking levels. In an inquiry classroom, students who have high level of critical thinking skills should become less dependent on teachers and textbooks, create knowledge and so, the teachers can be a facilitator of learning. Instructors should have plans and ways to be actively engaged in the learning process. For the present study, the teacher should encourage students to take increasing responsibility for his learning (the mean score of class management strategies / communication with the students was 2.3). Additionally, in the present study, metacognitive self regulation (MSR) is one of the other learning strategies that can be a possible variable to affect university students' biochemistry achievement. Pintrich (2004) stated that using metacognitive strategies can have an important effect on students' achievement. Research findings of the Akyol, Sungur ve Tekkaya (2010) revealed that metacognitive self regulation strategy use were found to make a statistically significant positive contribution to

the prediction of students' achievement in science. Students who can plan (setting goals for studying, generating questions before reading a text, and doing a task analysis of the problem), monitor (following of attention while listening to a lecture, self-testing through the use of questions about the text material to check for understanding, using test-taking strategies) and regulate their own cognitive activities (Pintrich, Smith, Garcia, & McKeachie, 1993) can be more active learners and show higher performance levels (Hammann & Stevens 1998). Therefore, teachers may organize educational settings which encourage students to use metacognitive strategies (Akyol, Sungur & Tekkaya, 2010). Teachers should help the learner about using appropriate strategies as what they are, how they operate and when they should be applied; so that students can realize their understanding about how they learn. Additionally, teachers can design open-ended instructional activities so students maintain an active and on-going awareness of task demands (Cubukcu, 2008).

Present study demonstrated that effort regulation may be a possible factor influencing university students' biochemistry achievement. It is defined as "the tendency to maintain focus and effort toward goals despite potential distractions" (Corno, 1994, p. 229). Many educational researchers stress that effort regulation is a strong predictor of academic success (Doljanac, 1994; Lee, 1997; Wolters, 1998). According to Langley, Wambach, Brothen and Madyun (2004), effort regulation differentiates between high and low achieving students and instructors may help students how they persist in difficult task since effort regulation should be taught to build learning skills gradually (Alderman, 1999).

Knowledge of cognition and regulation of cognition was taken into consideration to explain the factors that have an effect on students' biochemistry achievement in the present study. The results revealed that especially, high achieving students had higher total score on subscales of regulation of cognition than average and low achieving students' mean scores on the same subscales. Regulation of cognition is defined as "metacognitive activities that help control one's thinking or learning" (Shraw & Moshman, 1995, p. 354). The presence of positive relationships between regulation of cognition and academic achievement was demonstrated by various studies (Topcu & Tüzung, 2009; Baker, 2005; Peklaj & Pecjak, 2002; Taraban, Rynearson & Kerr, 2000). Metacognitive knowledge increases from low to high achieving students and teachers' role in developing students' metacognition is very important (Peklaj & Pecjak, 2002; Annevirta & Vauras, 2006). Thus, teachers should help students to make them aware of how they can be a skillful learner and how they can take the responsibility of their learning.

The results of this study revealed that low achieving students had the highest mean scores on rote learning orientations. However, as in all other science courses, in biochemistry they should connect the new knowledge with preexisting ones to build meaningful learning which is having deep understanding of complex ideas or subjects. It is pointed out that, meaningful learning orientation is significant for meaningful understanding of students in science (Cavallo, 1996). Students must connect each biochemistry concepts with each other in a meaningful way in order to recognize further biological concepts. Teachers can encourage this process by carefully considering the type and organization of information as well as instructional strategies.

The present study also includes some semi-structured open-ended interview questions and classroom observations to obtaining further information about possible factors affecting students' biochemistry success. Especially, high and average achieving students emphasized that biochemistry is an interesting course and they want to learn further about the course. They believe that note taking is actually very important to get success in examinations. Low achieving students consider that biochemistry subjects are really complex and difficult but, they prefer to read their notes just before exam and unfortunately, they do not study regularly and connect pre-existing knowledge with new ones to have meaningful learning (the mean score of students' preparation for biochemistry course was 2.3). They think that biochemistry subjects are away from them and difficult to understand. Looking for the mean score of students' motivation to learning biochemistry which was 2.2, it is understood that students were not apparent target of attention. So the teacher should know students ideas about the course and try to eliminate these negative feelings, since they should have high motivation to give greater effort and persist longer at academic tasks (Pintrich & Schunk, 2002).

In conclusion, different variables may be important for university students' biochemistry achievement which was exposed with the present study. Motivational and self-regulated learning strategies as well as knowledge and regulation of cognition can have direct consequence on biochemistry lecture achievement. Furthermore effects of students' approaches, students' preparation and participation, teaching process, content organization and class management strategies may have considerable end results influencing Turkish university students' biochemistry achievement. The findings of the studies may not necessarily be the same as the findings of studies in other cultures. Since, nature of strategy use may not be the same across different cultures. Therefore, future studies could examine the relationship among students' other learning strategies in relation with students' biochemistry

achievement in different cultures. Moreover, case study could be one of the useful approaches to examine the effects of different factors and possibilities which lead to success/failure on different subject areas and contexts.

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